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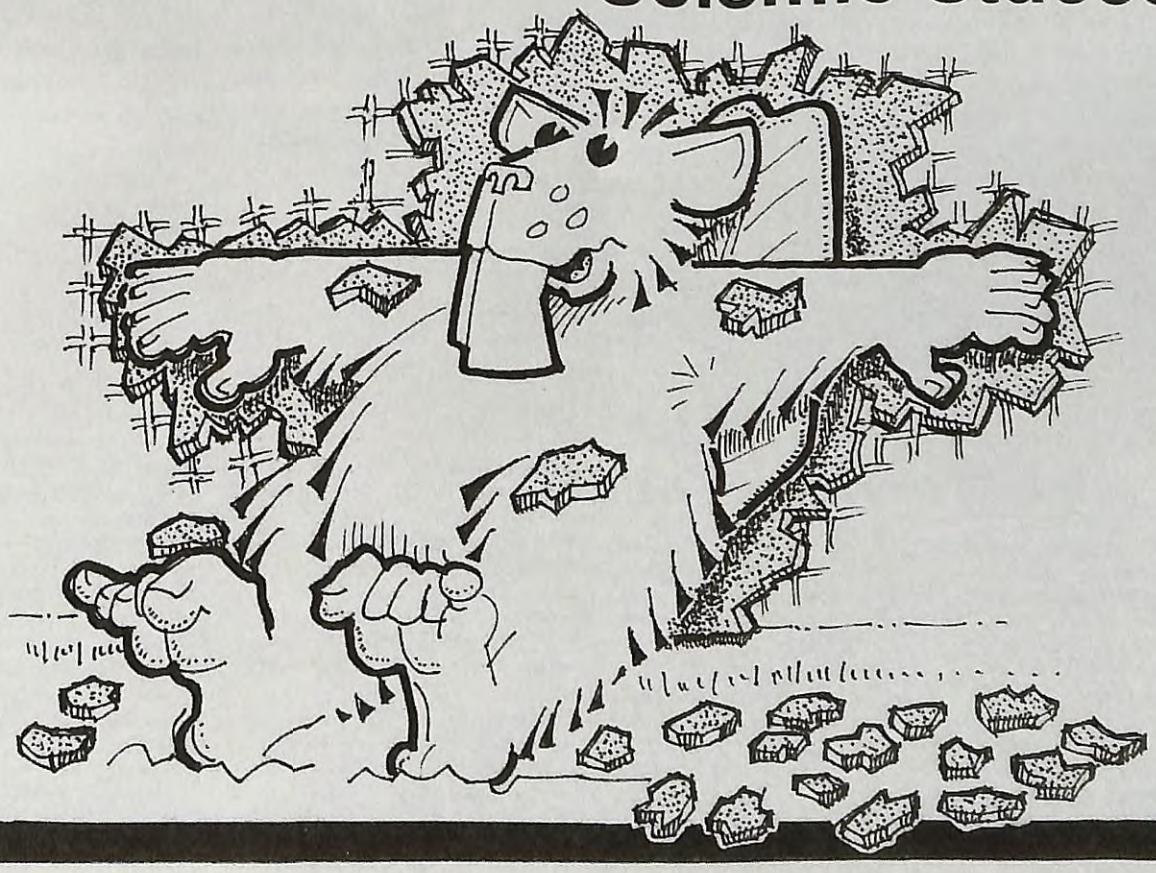
Seismic Stucco



From the Editor . . .

We are hearing it from all quarters: we are facing a major challenge; our own industry is caught up in it, and there is no simple answer. What is the issue? What is the challenge? It is the changing demographic shift in society caused by the baby boom after the Second World War. All those "boomers" born in the late 1940s are now entering retirement age.

The consequences of such a large proportion of the population entering retirement age at the same time will be serious for everyone. The construction industry is one that requires a fair bit of muscle power, which is why it has tended to rely on young workers. As we get older, it just gets harder to do some of the manual tasks that need to be done on the job site. Running up and down ladders and scaffolds or lifting those 2 x 4s or 2 x 10s just gets more difficult! This suggests that we need to be more open and get serious in the examination of how we do our work.

We already have serious labour shortages in the major cities experiencing development booms right now. This is driving attempts to develop quick training programs to provide a limited amount of training – just enough to give a few skills to young people so they can quickly become productive employees.

These approaches may offer short-term relief, but we must also look at the longer term. We need to consider seriously just how we build today. Perhaps we need to review the entire process and look at new industrialized manufacturing processes. We may need to consider seriously the lessons learned in the Scandinavian countries after the Second World War. At that time, those countries faced both a housing and labour shortage.

On top of this, the social culture and workplace regulations in Scandinavia require employers to make more long-term commitments to their employees. Hiring and firing people on a daily basis is not done lightly. To solve their labour capacity problems, the Scandinavian construction industry shifted a large proportion of its work to factory manufacturing. Thus in Sweden today, most housing is pre-manufactured in a factory, so the builder on the site primarily handles site preparation, the assembly of manufactured components (often completed, panellized elements), and service hook-ups.

Factory manufacture permits better quality control, since the work is done in a climate controlled environment, not affected by the weather. It also allows standardized tasks and the introduction of automation. Simpler tasks allow the effective use of employees with modest skills.

Whether the newcomers to the industry are young people leaving school or immigrants, we need to ensure that training programs give trainees more than simple "how-to" instruction for a narrow range of tasks, but also offer a more holistic background to construction. It has taken a while, but more people are becoming aware that a house is a system – more than simply an assembly of materials and components. We need to stress the importance of understanding what it is we do, and the place discrete tasks on a job site have on the performance of a building. Training needs to include assessment tools, so everyone on the job site gains an appreciation for the complexity of a building. Everyone on the job site needs to be empowered to ask questions; especially if they see something they either don't understand or see leading to other problems down the road.

Richard Kadulski,
Editor

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Seismic Stucco:
Earthquake Performance of Rain Screen Stucco Wall Systems

Authorities and homeowners on the West Coast of BC have long been concerned about the effect of a major earthquake on existing and new single family houses, especially since these are typically not engineered for high risk seismic zones. Considerable research in Canada, the US and Japan has been done or is underway to assess the earthquake resistance of wood frame buildings.

Recent changes to the building regulations on the West Coast now require a rain screen cavity between the wood frame and stucco. This has raised the question as to how a rain screen stucco system would work in an earthquake and, can this be accounted for in the design process.

The University of British Columbia engineering research laboratories have a "shake table" that can simulate earthquakes. A research project at the university set out to do a comparative earthquake performance evaluation of rain screen and non-rainscreen stucco systems. A secondary research objective was to suggest refinements to the design of rain screen stucco systems to improve earthquake performance. The profiles of three recent earthquakes were used in the dynamic tests of a two-storey house with stucco cladding. They were the Nahanni earthquake (1985, Richter magnitude 6.9), the Landers earthquake (1992, Richter 7.5) and the Kobe earthquake (1994, Richter 6.9).

The study tested a number of wall types to determine the strength of different types of stucco as well as several tests of full-scale buildings that included finishes such as doors, windows, gypsum wallboard and stucco. It was found that traditional stucco exterior cladding provides a considerable amount of stiffness and strength to the wall system, although it is not accounted for when calculating the earthquake resistance of the structure.

The two shake table tests subjected a two-storey house with stucco cladding to each of the three earthquakes. One house was clad with conventional, non-rainscreen stucco, and the second house had rain screen stucco cladding.

Before doing the full-scale building test, a series of nine 8 ft x 8 ft wall panels with different stucco detailing were tested. These tests looked at the performance of different stucco systems under racking loads, which were then used to determine the configuration used for the shake table tests. The wall configurations tested included:

- 2 panels with conventional stucco detailing
- 2 panels with rain screen stucco
- 1 rain screen stucco panel with different lath
- 2 rain screen stucco panels with two different fastener types
- 1 rain screen stucco with different fastener spacing
- 1 rain screen stucco panel with different furring

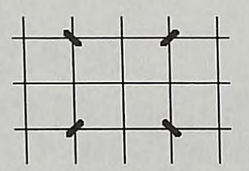
Staples were the main lath fastener for the static tests. Staples were the only lath fastener used for the dynamic tests, although nails are the dominant lath fasteners currently used in British Columbia.

The staples for the static and dynamic tests were electroplated 16-gauge staples, either 1 ½" (38 mm) or 2" (50 mm) long. The staples for static tests were 16-gauge stainless steel staples, either 1 ½" (38 mm) or 2" (50 mm) long.

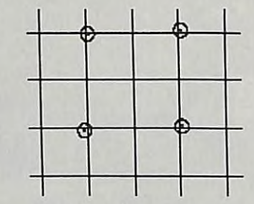
Code Compliance

The stucco test panels were fully compliant with both the 1995 National Building Code of Canada (NBC) and the US 1997 Uniform Building Code (UBC97).

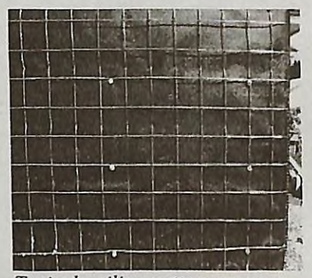
Since both of the codes apply to non-rainscreen stucco, the most significant code issue is the depth of penetration of the lath fastener. NBC requires a 1" (25 mm) penetration into the framing member or full depth penetration of the sheathing. UBC97 does not have a specific penetration requirement for lath nails



Staple fastening of lath is recommended.



Traditional nailing of stucco lath



Typical nailing pattern as seen on a job site.

and staples but it requires the lath screws to penetrate wood framing by a minimum of 16 mm.

The test results highlighted the importance of the lath fastener penetration depth for seismic performance.

Both structures (non-rainscreen and rain screen) performed very well for the strong ground motions of the Kobe earthquake. Neither test structure sustained any significant earthquake damage. The only evidence of earthquake damage was small cracks emanating from the window and door corners.

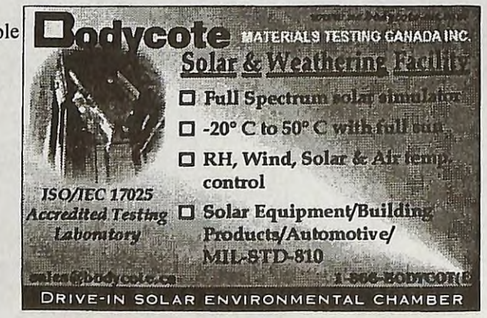
The non-rainscreen test house was stiffer than the rain screen house. Within the context of maximum drifts permitted by the code, the difference between the two test results is not significant.

Significant conclusions from the testing are as follows:

1. Pressure treated plywood strapping has better ductility than pressure-treated SPF strapping. Use of plywood strapping is recommended.
2. Roofing nails have a superior performance to common nails as strapping fasteners.
3. Short strapping nails (38 mm or 1½") precipitate brittle failure of the cladding. Long strapping roofing nails (64 mm or 2½") are better.
4. Earthquake performance of panels with staple lath fasteners is superior to that of panels with nail lath fasteners. Panels with longer staples (50 mm or 2") have substantially better strength than panels with shorter staples (38 mm or 1½"), which is why 50 mm (2") stainless steel lath staples are recommended. Both legs of the staple must penetrate the framing.
5. For seismic loading, lath fasteners (nails and staples) should meet one of the following two alternative penetration requirements: have a minimum penetration of 25 mm into the framing member, or a total penetration of the sheathing and a minimum penetration of 16 mm into the framing members.
6. Rain screen stucco has a comparable earthquake performance to that of non-rainscreen stucco.
7. Stucco has the potential for substantial mitigation of earthquake damage. Refinements to current rain screen stucco construction practice will make a major contribution to capitalizing on this impressive mitigation potential.

The overall conclusion is that both rain screen and non-rainscreen stucco have the potential to effectively eliminate major structural earthquake damage in residential wood frame buildings (single family and multi-unit construction).☼

Static and Dynamic Earthquake Testing of Rainscreen Stucco Systems for British Columbia Residential Wood Frame Construction
by: G.W. Taylor, H.G.L. Prion, C.E. Ventura and M. Kharrazi (TBG Seismic Consultants Ltd. and Department of Civil Engineering, University of British Columbia) for CMHC Research Division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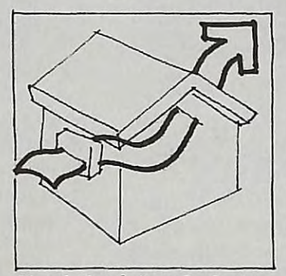
Ventilation 101

We all understand that homes need to be ventilated. What is less well understood is how to provide ventilation effectively in a home.
Forced warm air heating and ventilation must not be confused.

When considering ventilation, it is important to know why we need it. The purpose of ventilation is to maintain healthy indoor conditions for occupants. Ventilation for occupants must not be confused with the ventilation requirements for the structure, or with the combustion air requirements for fuel-fired equipment.

Ventilation brings fresh air into the house and exhausts stale, moist air to the outside. The amount of ventilation required is related to the number of people in the house and not to the volume of the house. That is why total system capacity is based on the number and types of rooms. The fresh outdoor air brought into the house must also be distributed to the living areas, especially to the bedrooms.



Ventilation brings fresh air in and exhausts stale moist air out.

The exchange of air can happen in many ways. Traditionally, a significant portion of the air change in houses happened as a result of dilution air flow up the flue. This was especially the case during cold weather because the draft required by the flues used air in the house as part of the required dilution air. Modern heating equipment has changed the dynamics of a home's air change. For example, electric heating eliminates the need for flues. High-efficiency combustion appliances reduce the air flow up a flue by more efficient combustion, by restricting flue air leakage between firing periods, and by eliminating the need for open flues when sealed combustion equipment is used.

The increased use of such heating systems combined with increased emphasis on air sealing the building envelope has led to a concern that the natural air change may be inadequate to provide a healthy environment.

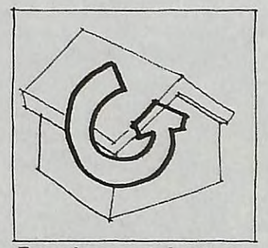
Ventilation and heating systems

There is much confusion about ventilation when homes have a forced warm air heating system. Too many people assume that the air circulation provided by the forced warm air heating is the same thing as ventilation. This confusion may arise because often the ventilation system is connected to a forced air heating system so the heating ducts circulate the fresh incoming air.

It must be stressed that forced warm air heating systems only re-circulate the air within the house. The air movement has nothing to do with the exchange of air between inside and outside. Only if the fresh air specially introduced into the house is circulated by the forced air system does the heating system become part of the ventilation system.

Forced warm air heating and ventilation must not be confused.

Where there is no forced air heating, then a dedicated distribution system must be installed. Because the system only handles ventilation air, smaller ducts can be used and the supply fan can be smaller than a normal furnace circulation fan. The supply fan must operate at the same time and rate as the principal exhaust fan to avoid either pressurizing or depressurizing the house.

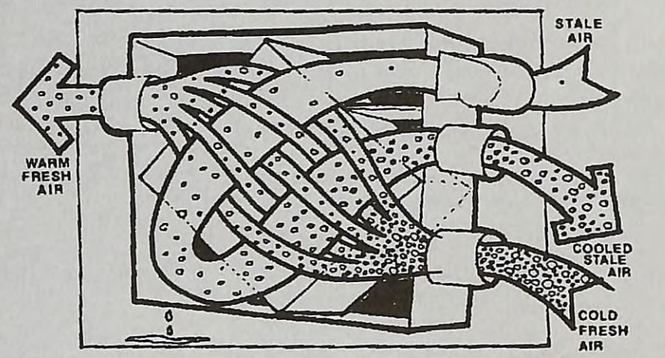


Forced warm air heating systems only re-circulate the air within the house.

In all cold climates, the ventilation air introduced must be preheated to avoid occupant discomfort. This is now most commonly done with a heat recovery ventilator, which also reduces the heating energy penalty associated with ventilation.

A properly designed, balanced ventilation system is independent of any other exhaust appliances in the house and will not be affected by exhaust fans.

The ventilation system does not provide the make-up air needs for other equipment. As well, the ventilation system does not provide cooling.☼



Heat Recovery Ventilator Basics

The primary purpose of an HRV is to continuously bring fresh, filtered air into the house and to exhaust stale, moist air to the outside. The heat exchange core tempers incoming fresh air and saves some of the heat energy. The rate of continuous ventilation needed depends on the number of people in the house.

A properly installed ventilation system ensures continuous fresh air to the house. This also means little if any window condensation; no lingering stuffy feeling; or, where there are smokers, reduced cigarette odours. With a continuous ventilation system, windows can be kept closed to provide a quiet interior without compromising indoor air quality or security.

Location of the HRV

The location of the HRV unit must allow easy service access. Areas such as the laundry, furnace room or basement are suitable. Cold attics and garages are never a desirable location and must be avoided. As well, there must be adequate space for duct connections.

Location of hoods

For clean, fresh air the intake hood must be at least 18 inches above ground. The fresh air intake must be at least 6 feet away from a dryer vent, furnace or hot water tank exhaust vent, gas meter, oil tank or the HRV exhaust air hood, and away from locations where car exhaust can be sucked in.

Exhaust air requirements

Continuous exhaust air is drawn from each bathroom and from the kitchen. The HRV exhaust replaces the need for a separate exhaust fan for the bathrooms. For peak kitchen exhaust, a range hood directly venting to the outside must be used.

HRVs and forced warm air heating system

Most people who choose a forced warm air heating system integrate the heating with the ventilation so that the furnace blower and ductwork distribute the fresh ventilation air. The preheated fresh air from the HRV should be directly connected to the horizontal cold air return at least 6 feet from the furnace.

Where the furnace is to be run continuously, it should have a variable speed or electronically commutated motor. These are quiet, energy efficient motors that can be set to run continuously at low speed. Today's high efficiency furnaces generally have variable speed motors available as an option if they are not standard.

HRVs and non forced warm air heating system

If the home has a non-forced air heating system, such as baseboard heating or in-floor radiant heating, then fresh ventilation air must be delivered at the ceiling or high on the wall of bedrooms, living room, dining room and other rooms.

HRV maintenance

For good air quality the HRV must be regularly cleaned and maintained. Each manufacturer provides maintenance instructions.

- The filters, core and fans can all usually be removed without tools.
- Intake hood screen must be inspected regularly for lint and leaf blockage.
- Filters must be inspected and cleaned as required every two to four months.
- Fan motors generally do not require regular maintenance. Consult the manufacturers' maintenance instructions.☼

R-2000

For information on the R-2000 Program, contact your local program office, or call 1-800-387-2000 www.R-2000.ca

What's a Heat Pump?

A heat pump is a machine that moves heat from a low temperature zone to a higher temperature zone by adding energy. A heat pump is little more than an air conditioner that can also run "backwards." When running backwards, the pump takes heat from the outside air and moves it indoors – the reverse of an air conditioner, which takes heat out of a building.

An often misunderstood question is how the heat pump can extract heat from the outside air when it's cold. The air-to-air heat pump takes heat from the air by evaporating a refrigerant in its outside coil at a temperature lower than the outside air, causing heat to flow from the air to the refrigerant, because even cold outside air always contains a certain amount of heat. At 0°C or even at 0°F (-17°C), there is still a small amount of heat in the air, although the cooler the air, the less heat it contains.

The main reason for considering a heat pump is its inherent high efficiency when compared to other methods of electric resistance heating, especially when electricity is the main energy option. Heat pump efficiency for heating is described as the coefficient of performance (COP). COP is defined as the heat output divided by the power input required to produce the heat. For most air source heat pumps, the COP will be in the range of 1.75 to 3. Another way of looking at it is that for every 1 kWh the unit uses, it can provide the equivalent of 1.75 to 3 kWh.

It must be noted that the COP will depend on the outdoor air temperature – the milder the climate, the higher the overall COP. For practical reasons, air-to-air heat pumps are only practical in mild climate areas – in Canada that would be the West Coast, for seasonally used buildings not used in the winter, or as a supplementary heat source during milder weather.

A heat pump has specific operating conditions that have to be accounted for in its basic design. The indoor coil, that acts as an evaporator coil in the summer cycle, is the condenser coil in the winter. As a result, it must have a larger surface area to keep the condensing temperatures from being too high. The compressor in a heat pump must be designed differently from the one in a summer air conditioner because it has to run year-round and at different operating pressures than a straight air conditioner.

The air handling capacity of the heat pump unit and the duct system must be sized to ensure there is enough condensing action. A heater in the unit is needed to keep the compressor oil free of refrigerant during low temperature starting conditions.

When in cooling mode, heat is transferred into the refrigerant. Warm indoor air is cooled and dehumidified, then redistributed through the duct system. The heat absorbed in the refrigerant is rejected outside by the outdoor coil.

In the heating season when the thermostat demands heat, a valve is repositioned to reverse the cycle. The heat absorbed from the outside air changes the refrigerant from a low temperature liquid to a low temperature, low pressure gas. This gas is drawn into the compressor, compressed into a high pressure, high temperature gas and discharged to the indoor coil. The indoor coil, now acting as the condenser, gives up the heat of the high temperature gas to the air moving across the coil, thus heating the indoor air.

During the heating cycle, outside air passing through the outdoor coil gives up its heat to the refrigerant. Even though the outside air may only be +1°C (slightly above freezing) the reduction in temperature, as it gives up its heat, will cause moisture contained in the air to freeze so frost will form on the outdoor coil. A defrost strategy has to be part of the system design. Sometimes, the heat pump may have a resistance heater to melt the frost. Another type may simply reverse the valve, so that for a short period the unit takes house heat outside to melt the frost build-up. Evidently, this approach lowers the overall efficiency of the unit, and is best suited for mild climates.

Air-to-air heat pump manufacturers provide COP ratings at specific outdoor temperature ranges. When the COP is calculated over a period of time such as the full heating season, an average COP is obtained. The result is known as the seasonal heating performance factor or HSPF. The HSPF is not unlike the AFUE (annual fuel unitization of energy) for a gas furnace.

The sizing of a heat pump must be done carefully, especially if the pump is to also to

provide cooling, and the balance point must be calculated. The balance point is the outdoor temperature at which the unit's heating capacity matches the building heat loss and is very important in correctly sizing the pump.

As the outdoor temperature falls and the balance point is reached, it is necessary to introduce supplemental heat. For optimum efficiency, heat pump systems are rarely sized for the full peak capacity. Typically, they are sized to provide about 75 to 80% of design capacity, so a supplemental heat source is needed usually this is provided by an electric heater. The amount of supplemental heat needed is the difference between the total heat loss of the house and the heat pump capacity at the design temperature. To avoid unnecessarily large amounts of electric heat being energized simultaneously causing short fan cycling and poor comfort control, outdoor thermostats are wired into the heater control circuit so that only as much electric heat as is actually needed at each temperature is energized.

Manufacturers provide tables that indicate the available heater sizes for a selected model heat pump.

If a heat pump is going to be retrofitted to an existing forced-air heating system, the furnace fan and motor must be checked to ensure that the system has enough static pressure capability to deliver 450 cfm per ton across the indoor coil. It must also be recognized that the air temperature at the fan coil is lower than in a gas furnace, so heat pump systems require larger air flows to deliver the same amount of heat. The cooler air temperatures in the forced warm air stream require a careful layout to avoid discomfort and a cooling sensation for the residents. ☼

Geothermal Heat Pump Systems

A geothermal heat pump is similar to an air-to-air heat pump, except that it uses the ground or a water body as the source of heat. Deep ground temperatures are fairly stable, and are always above freezing temperatures (except in regions with permafrost). Annual average ground temperatures in most Canadian locations south of 60°N range from 5° to 12°C. Consequently, geothermal heat pumps will have a higher efficiency that will allow them to provide heat year round

A geothermal heating system has three components: a well drilled into the ground, a pipe system, and a heat pump. The depth of the well will depend on soil conditions. It can be anywhere from 100 to 400 feet deep. Placing a slightly stretched out coil of collector pipe in a horizontal trench is another option. This is often referred to as a horizontal slinky.

A heat-transfer fluid, a liquid at a temperature lower than the ground temperature, is pumped into the borehole well through the pipe system. Since the borehole is colder than the surrounding ground, heat flows towards the pipe. This raises the temperature of the heat transfer fluid in the pipe by a degree or two. This heat is then absorbed by the heat pump which raises the temperature to a useable level and is then transferred through a fan coil for forced warm air heating systems or piping for hydriodic baseboards or radiant in-floor heating.

While the soil provides most of the heat, the heat pump still requires some external energy to drive it, but this energy also becomes heat. However, most of the heat supplied to the house, about 70%, comes from the ground. The higher the temperature of the soil the less the heat pump has to work in raising the temperature, and the better the overall system efficiency. Another way to increase the efficiency of the heat pump is to use a low-temperature heating system, which is why in-floor heating systems that operate at a very low temperature are very efficient.

When heat is extracted from the ground, the soil around it is cooled down, but the drop in temperature is relatively small. At a distance of 10 metres from the well, the drop in soil temperature after 10 years of operation (if the soil temperature is not warmed up) may be about 0.5°C. If the wells are drilled too close to each other, the cooling around each borehole may create interference effects, so that the temperature of the heat transfer fluid drops at a slightly greater rate than if the borehole had been on its own, decreasing the overall performance.

All things considered, geothermal heating can be considered to be an environmentally friendly heating method because about 70% of heat for the house is taken from the ground, and it does not cause any local air pollution. In most cases, the drop in soil temperature over the heating season is reversed during the summer by heat from the sun.

The European Heat Pump Association estimates that by 2010, 30% of all space heating in Sweden will be through heat pumps. And Sweden is only a small country in the European Union.☼

Efficiency Regulations for Geothermal Heat Pumps

Natural Resources Canada (NRCan) is proposing to amend federal energy efficiency regulations to incorporate more stringent efficiency requirements for ground- and water-source heat pumps. Ground-source heat pump equipment for sale or lease in Canada will be required to comply with minimum energy performance requirements effective June 2, 2006.

The proposed regulation applies to products that do not exceed 40 kilowatts (135,000 Btu/h) in cooling or heating capacity:

- Closed loop ground-source units used for heating will have to have a minimum COP of 3.1.
- Open loop ground-water units used for heating will have to have a minimum COP of 3.6.

Geothermal Heat Pumps: one country's experience

Buildings represent a large portion of the energy used in the industrialized world. In Canada, 30% of all energy use is for buildings. (And the residential sector accounts for more than half of that).

In Sweden, a large proportion of space heating is provided by electricity, and buildings account for about 40% of total energy use. Over the last thirty years, while the total heated floor area in Sweden has increased by 40%, during the same time energy use has been largely constant because the energy efficiency of buildings has been improved.

Another reason energy use has been constant is the ever-increasing number of heat pumps used for space heating. Geothermal heating for single family houses is becoming increasingly popular. Today there are more than 250,000 such systems, which represent more than 12% of all single family dwellings.

Because of the constant ground temperatures, each system reduces purchased energy by at least one third. Taken together, these installations produce about 10 TWh of heat just for housing. As with any renewable energy application, the savings of purchased energy do not appear in energy statistics.

The Swedes estimate that CO_2 emissions have decreased by 3.5% due to using ground-based cooling and heating.☼

Gatineau Bans Non-Traditional Construction

The push for environmentally sensitive, energy efficient building has many considering non-traditional construction practices and materials. Straw bale construction and rammed earth are two technologies that have captured people's imagination. They may not be appropriate in all applications, and you will not be building them in your next subdivision project, but they do offer a solution for some locations and designs. There is enough structural and performance information available to satisfy code officials that in some US jurisdictions they have been written into the building code.

It is unfortunate to learn that in some jurisdictions the NIMBY* syndrome trumps even technical considerations. The new city of Gatineau (which is the amalgamation of several communities on the Quebec side of the Ottawa River, across from Parliament Hill) has adopted a new regulation that will ban straw bale construction throughout its territory. The new regulation states "It is prohibited to use a non-traditional wall system composed of straw bales or earthen walls, in assembling the wall of a structure." This overrides even the building code which allows unconventional construction provided it can be shown to meet the requirements of the building code.

The message from the City of Gatineau is that innovative ecological building techniques are not welcome - or officially allowed. This flies in the face of even the Quebec Government's sustainable development initiatives.☼

*Not In My Back Yard

Crawlspaces: To Ventilate or not to Ventilate

Crawlspaces have historically been a source of moisture problems in houses, so crawlspaces have to be designed and built with care. Unfortunately, there are still many misconceptions about how crawlspaces function and how they should be built.

Soil is a major source of moisture into a building. A durable and low-permeance vapour barrier should always be installed over the ground, and the surface of the crawlspace floor should be sloped to drains. In the case where the crawlspace floor is above the surrounding grade, this drain can be to the exterior.

Crawlspace ventilation

Unlike wall or roof assembly ventilation, crawlspace ventilation will rarely remove more moisture than it delivers, even in cold climates. This is because crawlspaces do not get the benefit of solar heating and there is the large thermal mass of the foundation construction and soil coupled to cool deep soil temperatures.

In the warm humid summer weather, crawlspace ventilation is likely to cause condensation precisely at the same temperature conditions that are also likely to support fast mould growth and corrosion. Ventilating a crawlspace is not a reliable means of removing or controlling crawlspace moisture.

Crawlspaces should be designed and built to be conditioned spaces. Consider them as shallow basements. This means airtight, insulated perimeter walls and some means of removing water vapour that might be present from construction moisture and incidental sources. In other words, the crawlspace must be conditioned and ventilated like the rest of the house. Such an approach provides better and more reliable moisture performance independent of climate, and protects any plumbing and heating systems in the space from temperature extremes – improving the quality of the space, reducing the amount of insulation required (while making it easier to install), and making the important task of air sealing easier to accomplish.

The National Building Code is very clear on this issue. It defines any crawlspace that has heating supplied to it as a heated crawlspace that must be air-sealed, insulated and ventilated with the rest of the house.

If the crawlspace is to be treated as unheated, then the floor over it must be air-sealed and insulated. Any heating ducts or pipes in the space must be fully insulated to bring them thermally back inside the heated space.☼

Letter to the Editor

Re: Moisture Movement through Concrete Foundations (Solplan Review No. 117, July 2004)

I have been receiving Solplan Review for a few years now, and I must say that your view on residential construction has kept my interest.

I found the suggestion that the drain tile be installed lower than the footing pad interesting. I have been using a piece of 6-mil poly placed under the footing pad before the concrete is poured. This has worked well. I can see that placing the poly under the footing and slab, and dropping the perimeter drain lower than the bottom of the footing, should provide a complete moisture barrier for the foundation.

I developed this detail on my own, but still wonder whether there could be any problems with it. My footing took longer to cure, but I think that only makes it stronger.

Pierre Mourant
Caraquet, NB

Thanks for your comments. You are not alone in being concerned about managing ground water moisture on the foundations. I am aware of other builders who are successfully using a similar detail, placing a sheet of poly under the footing or even wrapping the whole footing. If you line the footing forms, another bonus is that the lumber used for the footings, when stripped, is much cleaner than if the concrete is poured against the forms themselves.

There are commercially available fabric forming products that are water-resistant and do exactly the same job. They are used to reduce the moisture loading on the concrete.

What you are doing is definitely good building practice. Ed.

First Residential Fuel Cell Installed in Canada

Fuel Cell Technologies Limited, a developer and producer of solid oxide fuel cells has installed its first residential fuel cell system in Canada in a house at the Canadian Centre for Housing Technology (CCHT) in Ottawa.

The five-kilowatt system will run on natural gas and use a solid oxide technology developed by Siemens Westinghouse Power Corporation. The second-generation system features improvements from earlier prototypes that include gas-powered heat-up to allow the unit to be started without an electrical power source; the ability to use low fuel pressures; and the elimination of the purge gas – an expensive gas mixture that was required to protect the cell stacks during system start-up and shutdown. In addition the inverter, which converts the fuel-cell direct current energy into AC power, was redesigned to satisfy residential standards. The system also features improved control of the output power and seamless transfer between the grid-dependent and grid-independent modes without operator supervision.

The fuel cell has been placed in one of CCHT's twin research houses which offer an intensively monitored real-world environment with simulated occupancy to assess the performance of residential energy technologies. CCHT researchers will also examine the heating, ventilation and air-conditioning interface, the control strategies and the grid connection to allow easier integration of fuel cells into the house's energy systems.

This is part of a joint project with Natural Resources Canada. Also participating are electric and natural gas utilities, manufacturers, research agencies and other government departments. The work is part of the Technology and Innovation Initiative's Decentralized Energy Production Program which has contributed funding to this demonstration project.☼

From Associates Link, HRAI

The Healthy House Institute to Close

The Healthy House Institute was established by John and Lynn Bower in the early 1980s. The Institute grew out of a need they had when Lynn realized her health problems were the result of exposure to numerous chemicals. John, who was a builder, set out to build a healthy home so Lynn could have a safe environment to retreat to.

The Healthy House Institute was one of the few independent organizations producing healthy housing information. It quickly established a reputation for credible, easily accessible information on healthy living. Over the years, the Bowers built several healthy houses and consulted on others. The limited amount of information available on the subject of healthy home environments led them to write dozens of articles, author five books and produce six videos. John's The Healthy House, which has gone through four editions, is considered a classic in the field. Lynn's Creating a Healthy Household has been cited repeatedly as a veritable encyclopaedia for living a healthy lifestyle.

There is still a demand for Healthy House information, but the Bowers no longer have the drive or the time to do all the research necessary to update their books and keep them in print.

While there has been some interest in acquiring the Healthy House Institute, no one has come forward with a firm commitment. As a result, the Institute will close its doors and shut down its website (*www.hhinst.com*) when the current inventory of books and videos is depleted.

Although new editions of their materials won't be forthcoming, the existing publications still contain a phenomenal amount of valuable information and can be found in libraries across the USA and Canada.

As The Heathy House Institute winds down, calls for healthy house information will be forwarded to American Pie (Public Information on the Environment) at *www.americanpie.org* This is a non-profit organization that provides answers about environment and air quality issues.

The closing of the Healthy House Institute is a sad commentary on the level of support for healthy housing. Valuable information is still needed, but there is little commitment to support an organization dedicated to the cause in the US.

Much valuable healthy house information is still available from CMHC, which is supporting ongoing research in the field.☼

Ontario's powerWISE ™

Six of Ontario's largest local electricity distribution companies will work cooperatively under the name "powerWISE" to deliver a major multi-year initiative designed to promote energy conservation to consumers and reduce the demand for electricity.

Enersource Hydro Mississauga, Hamilton Utilities Corporation, Hydro Ottawa Limited, PowerStream Inc., Toronto Hydro-Electric System Limited and Veridian Connections plan to invest a combined $70 million over the next three years on conservation and electricity-demand management programs. In total, the six utilities represent 1.65 million customers or about 40% of the electricity customers in Ontario. Consumer-oriented conservation initiatives under the powerWISE umbrella may include the promotion of energy efficient lighting and appliances, residential energy audit services, access to online services such as energy consumption calculators, and school education programs. A powerWISE website has already been developed. (*www.powerwise.ca*)

In addition to working together on conservation initiatives under powerWISE, the six utilities are taking a cooperative approach to smarter meters. They will develop a business case as well as financial and legal options for the delivery of smart meter services on a provincial scale. Smart meters measure how much electricity customers use each hour of the day. Time-of-use meters allow utilities to charge a higher price for electricity used during periods of high demand. The goal is to raise awareness about the cost of power and to encourage customers to reduce electricity during times when the price is high.

The Ontario government wants all Ontario customers to have smart meters by December 31, 2010.

If the powerWise program has the kind of impact in Ontario that BC Hydro's Power Smart Program has had in BC, it should go a long way toward reducing wasteful electricity consumption and encouraging efficient power use. ☼

Did you know?

Facts about Gas-Fired Appliance Flues

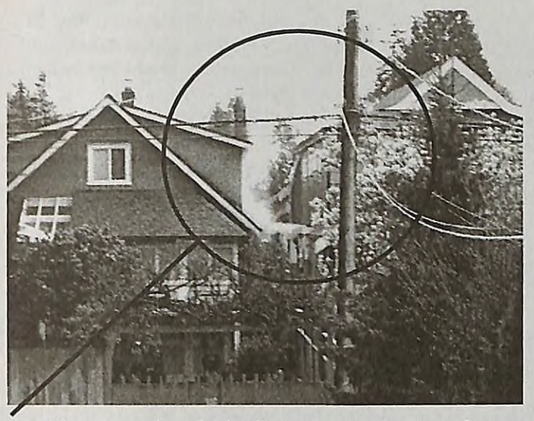
A furnace that is too large is not very efficient because it will fire for short cycles, which can lead to corrosion and the premature deterioration of the B-vent.

The combustion of gas produces a large volume of water. When the furnace first fires, the water vapour in the combustion gases enters a cold flue, so it will condense on any cold surface, such as near the end of the vent. If the furnace is short cycling, the flue does not warm up and evaporate the condensation that takes place in the cold flue before the furnace shuts down. Properly sized furnaces will have a longer firing time, so the combustion gases will warm up the flue and dry out any condensation that may have taken place on first firing.

The Gas Code requires B-vents to be insulated. The General Venting Requirements of the Gas Code (B149.1.05) Rule C.2.2. (Vent sizing tables) apply to vents internal to the structure below the roof line. Vents not enclosed in a chase below the roof line can still experience continuous condensation. This means that a B-vent running through an unheated attic needs to be insulated. Only the last three feet outside do not need to be insulated.

Non combustible foil-backed fibre insulation can be wrapped around the flue to provide the required insulation, but any material used for insulating the vent must be approved for the application. This is an important issue to keep in mind, especially in cold climates.☼

Venting of Gas Appliances



A. Flue gasses from high efficiency water heater in house on right. House on left has a bedroom window on the side facing the house on the right.

B. Vent gas plume from high efficiency water heater retrofited into an older house.

All combustion appliances must be vented. Traditionally, all combustion appliances were vented through chimneys or flues that went straight up through the roof. Today, high-efficiency gas appliances are widely being used, and will soon become the standard. These high-efficiency appliances still have to be vented, but rely on fans in the unit to move the gases, so that they do not have to be vented through the roof. Many are vented through plastic vent pipes through a wall.

The combustion flue gases from gas combustion contain large quantities of water vapour. The result of this is that, as the gases encounter cooler air (below the dew point of the gas), large clouds of steam are formed where the gases leave the house. In suburban locations, where the houses may be widely spaced, this may not be an issue. However, in more dense urban sites, where houses are closely spaced, the location of the vents is something that needs to be considered.

The moisture in the cloud leaving one house could condense onto the neighbouring house, which could mean an added moisture loading on the neighbouring house, and the potential of compromising the environmental loads on the neighbours. Photo A shows the steam cloud from a new house in Vancouver. It was observed by a neighbour. Photo B shows the vent plume from a high-efficiency heater retrofitted into an older house. Both photos were taken during relatively mild west coast weather. In cold weather, the clouds would be much more noticeable.

The lesson to be learned from these examples is not to avoid using high-efficiency appliances, but rather to locate venting carefully. Wherever possible, venting should be taken up through the roof rather than through the wall, even if it requires increasing the size of the vents unless there is a wide open space where the vent discharges its gases.

Manufacturers' instructions for calculating the length of vents must be followed at all times.☼

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Technical Research Committee News

Canadian Home Builders' Association

Roof Ventilation

The Building Code requires that roof spaces be vented. The intent of the requirement for attic ventilation is to deal with condensation that may occur in the roof space, but the current requirements were based on very limited testing and traditional practices.

To avoid moisture problems, the code also requires that construction be built airtight. Traditional construction practices did not pay much attention to air sealing, so the moisture driven out of the house by air leakage through the building envelope would condense. Because of the low insulation levels, the heat loss from the building would also assist in the drying of any condensation that took place.

Water stains in the attic of any older house are a telltale sign of periodic condensation that has taken place over time. The venting requirements were introduced to encourage airflow that would encourage the drying of any moisture that might build up in the attic.

The concern about attic ventilation is that large wind-driven air movements can actually depressurize the attic in relation to the house proper, which would then draw warm moist air from the interior through air leakage at the ceiling, thus contributing to moisture problems rather than solving them. This is especially a concern in winter when warm buoyant air from the house leaks through the ceiling penetrations. As the warm air encounters the cold space above the insulation, the moisture in the air will condense against any cold surface.

It is now well known that controlling airflow is very important. The Building Code itself (Section 9.19.1.1) recognizes that roof venting can be omitted if it can be shown that it is not needed. This section was originally drafted for use in manufactured housing, where an airtight ceiling assembly can be more easily attained than in on-site construction. Today we have materials and building systems, such as spray-in-place foam insulation products and structural insulated panels that can create airtight envelopes, thus eliminating the potential for air leakage and condensation.

In addition, the use of complex roof shapes and roof decks is making effective attic venting difficult. As well, fire officials are calling for closed soffits near property lines to reduce the potential for sparks and fire drawn into an attic space. Uplift of the roof structure is also a potential problem in high wind areas. As a result, there is considerable interest in revisiting the requirements for ventilating attic space now that the next cycle of code changes is about to start.

Construction-Generated Pollution

New construction, renovation, and demolition activity, generates pollution. Some causes of concern are contaminants in building materials that are released during demolition work. Other concerns are for disruption to the local environment.

In some regions close to fish bearing waterways, there are serious concerns that sediment could enter those waterways, affecting the water quality and choking off marine life. That is one of the reasons behind requirements to keep construction away from the water's edge, and for special containment measures for silt and water runoff from construction sites.

Similarly, construction activity contributes to air pollution that affects the entire community. To determine the exact situation, and how serious it may be, Environment Canada is leading an effort to reduce pollution generated by construction and demolition. CHBA has added a series of questions to its semi-annual survey of builder members to try to gauge current practices.

Domestic Hot Water Temperatures

Health and safety groups have been pressing to lower the temperature of domestic hot water at the taps to reduce the potential for scalding, which is a major cause of burns. That is the reasoning behind the drive to have water heating systems to be set at 49°C (120°F) rather than the current standard practice of 60°C (140°F). This is also the thinking behind the current Ontario requirements.

A task group looking at domestic hot water temperature has tabled its report recommending that water be stored at high temperature to avoid legionella contamination (60°C) but be delivered at a moderate temperature (49°C) in bathroom tubs and lavatories to avoid scalding. This would require the use of thermostatic mixing valves, similar to current requirements in Ontario. The Canadian Codes Commission will likely be considering this proposal at its June meeting.☼

The Technical Research Committee (TRC) is the industry's forum for the exchange of information on research and development in the housing sector.

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Current Recommendations on Fasteners for Treated Wood

Fasteners for ACQ or CA treated wood should be galvanized in accordance with ASTM A153. Stainless steel can be used for maximum service life or severe applications. Where appropriate, copper fasteners may also be used. Fasteners used in combination with metal connectors must be the same type of metal to avoid galvanic corrosion caused by dissimilar metals. For example stainless steel fasteners should not be used in combination with galvanized connectors. For borate treated wood used inside buildings, the same fasteners can be used as for untreated wood.

Current Recommendations on Flashing for Treated Wood

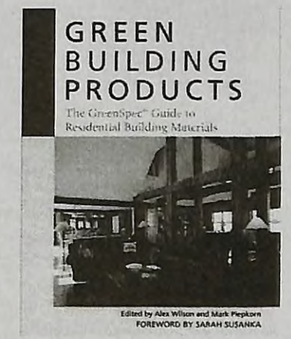
Flashing used in contact with treated wood must be compatible with the treated wood and be last long enough to be suitable for the intended application. Flashing must also be of the type of metal as any fasteners that penetrate through them to avoid galvanic corrosion. Copper and stainless steel are the most durable metals for flashing. Galvanized steel, in accordance with ASTM A653, G185 designation, is also suitable for use as flashing.

Other fasteners, connectors or hardware as recommended by the manufacturer. There may be additional products such as polymer or ceramic coatings, or vinyl or plastic flashings that are suitable for use with treated wood products. Consult the individual fastener, connector or flashing manufacturer for recommendations for use of their products with treated wood.

For further information on the new preservative products:
www.durable-wood.com/treated/fasteners.php

Green Building Products

A Product Guide for the Residential Building Market



A directory of residential green building products has been published by the editors of Environmental Building News. ***Green Building Products*** includes more than 1,400 green building products, everything from precast concrete foundation systems to recycled-plastic roofing shingles and high efficiency heating equipment. Products are organized according to building component but can also be found in the index under a manufacturer or product name. Each has a brief description along with manufacturers' information.

Products listed are taken from the GreenSpec® database of green building products which has been maintained by Environmental Building News since 1998. Listed products are selected based on criteria that the editors have developed over more than ten years. Criteria include recycled content, FSC-certified wood, avoidance of toxic constituents, reduction of construction impacts, energy or water savings, and contributing to a safe, healthy indoor environment.

Manufacturers do not pay to have products included in the GreenSpec database. Selections are based on careful in-house review by editorial staff. Maintaining an arm's-length relationship with manufacturers allows an unbiased evaluation of company claims. Details on the product selection process and the full list of criteria can be found at *www.BuildingGreen.com*.

In the foreword to Green Building Products, well-known author and residential architect Sarah Susanka described the book as a must for anyone—builder, designer, architect or homeowner - who wants to know the unbiased and unembellished truth about what's really 'green.'

Green Building Products edited by Alex Wilson and Mark Piepkorn is co-published by New Society Publishers and BuildingGreen, Inc.

Energy Answers

Rob Dumont

What is your opinion about radiant floor heating for houses?

There are positives and negatives.

On the positive side, most people seem to like that type of heating, which almost always consists of pipes carrying a warm liquid placed in the floors. To distribute the heat from the pipes to the floor surface, a concrete topping is poured around the tubes; alternatively, heat fin plates, often of aluminum, are attached to the pipes. Various floor coverings such as ceramic tile or thin wood floors have been used as the top surface. Although not ideal, radiant floors can be covered with a wall-to-wall carpet. (In this case a higher water temperature will be needed to drive heat through the insulation that the carpet provides.)

Here are some of the advantages of radiant systems:

1. Radiant floors generally have a warmer floor surface temperature, which makes the floor more comfortable in the heating season.
2. There is an absence of noise from creaking radiators or convectors, and there are no drafts from forced air ducts.
3. There is no smell of burnt dust from higher temperature heating surfaces, and special cleaning of the floor is not needed.
4. Compared with conventional forced air systems with conventional fan motors, the electric power to drive the liquid pump is often only about 1/5 that of the power to distribute an equivalent amount of heat by forced air.
5. With some boilers or water heaters, the same heating source can be used for both space heating and domestic water heating.
6. The water temperatures in the radiant systems can be low, and with the right kind of boiler the low water temperatures can result in higher efficiencies. (The lower water temperatures can even allow the boilers or water heaters to condense–a good thing provided the boiler or water heater is designed to handle the condensation.)

   Many homes in Europe use radiant floors. I have heard that in Germany radiant floors are the system of choice for new homes.

On the negative side, there are a number of challenges with radiant systems:

1. Generally there is a substantial cost premium to incorporate radiant floor heating into wood frame construction. The concrete topping, aluminum plates, heat distribution pipes and manifolds used for the floors make for a more expensive system than a forced air system. Concrete and aluminum are also relatively high-embodied energy materials compared with wood. In a multi-storey house, you also need some insulation beneath the radiant floor systems for good temperature control, and that insulation adds to the cost.
2. The extra weight of the concrete topping can add costs to the structural system for the house. A 38 mm (1 ½ inch) thick layer of concrete around the floor piping adds a dead load of about 15 to 20 pounds per square foot. This is significant relative to the live floor loads of about 30 to 40 pounds per square foot for typical residential floors.
3. There is no ventilation air distribution with the radiant heating systems, so a separate ventilation system will be needed to ensure good indoor air quality. Forced air systems do not have that disadvantage, as the ducts can carry ventilation air as well as air for heating (and cooling.)
4. A well-insulated house does not need a lot of space heating; as a consequence the floor surface temperature will not be very warm and the "warm floor" effect will be small. For instance, to provide 3 kW (10,200 BTU/hr) of heat to a well-insulated 100 square metre (1076 sq. ft.) floor house with an indoor air temperature of 22°C, the floor surface temperature needs to be only 3.6°C (6.5 °F) higher than 22°C.
5. Inexpensive condensing boilers with a long track record of durability and longevity are not yet available. A number of builders have used residential water heaters, but the efficiency of typical water heaters is not very high compared with condensing equipment. I have heard of severe condensation occurring in some water heaters that are used for space heating with radiant systems. The problem is that the return water temperature from the floor system is cold enough that continuous condensation occurs in the flue gas chimney of the water heater. The condensation drips down and splashes on the gas burners, creating carbon monoxide and potential air quality problems.

   Some water heaters are certified for use as both space and water heaters, and these are a good choice.

   As with any house using combustion equipment, I would recommend installing a carbon monoxide sensor.
6. Night setback of temperature in the house is more complicated with the concrete topped radiant floors because the thermal mass of the concrete delays the temperature fall in the house following setback, and prolongs the amount of time for the house temperature to recover.
7. Temperature controls for radiant floor heating systems tend to be more complicated; sometimes the systems use an outdoor air reset temperature to vary the fluid temperature in the pipes according to outdoor conditions. Untrained repair people can have problems diagnosing such a system.
8. Radiant heated concrete floors don't work all that well with direct gain passive solar heating systems. On a cold night the radiant floor will have to be warm to deliver heat to the house. When the sun comes out and starts delivering passive solar heat, the house thermostat will call for the pump to stop delivering heat to the radiant floor. Even though the heat flow is cut off, there is a lot of stored heat in the concrete floor, and that heat combined with the passive solar heat gains can overheat the space.

   I noticed this phenomenon in a newly built commercial building here in Saskatoon with a radiant floor and a large passive solar aperture. In February there was so much heat available from both the radiant floor and the passive solar contribution that the staff had to open an outside door because the air conditioner was not set up to run when the outdoor temperature was cold.
9. It is generally more difficult to incorporate air conditioning or cooling with a radiant floor system. Some work has been done with passing chilled water through the piping systems, but there are questions about the efficacy of that approach. A possible problem is that the floor surface temperature can go below the dew point temperature and mould will occur under carpets, furniture, cardboard boxes, etc. I would proceed with extreme caution with chilled floors, particularly in any location subject to high humidity.
10. Radiant floor systems can be very expensive to repair. One example I have heard of is an older radiant floor system in a church near Vancouver, B.C. To save money, iron pipes were used in the radiant heating system under the extensive ceramic tile floors. Several of the iron pipes have started leaking after about 20 years, and a major cost will have to be incurred to replace the entire floor system.
11. Some types of plastic piping used in radiant floor systems have had problems. At least two plastic piping systems have had major class action lawsuits associated with leaks.

For the house that my wife and I designed, I looked into radiant floor heating, but decided against it. There was a substantial cost premium, and that cost, along with the fact that we wanted hardwood floors which are not very compatible with leaking pipes, made us choose a forced air system.

In general I prefer to see dollars spent on improving the building envelope through better windows, thermal insulation, and air sealing rather than on heating systems. All of these expenditures on conservation will also improve thermal comfort.

However, for those who have the money and inclination, radiant floor systems can be satisfactory heating systems. They have the best cost-effectiveness when used with concrete slab-on-grade construction in buildings that don't need air conditioning. Just don't skimp on the underfloor insulation, and be very careful about solid concrete thermal bridges to the outdoors. The property of concrete that makes it a relatively good conductor of heat from the radiant floor piping also makes it a very good source of perimeter heat loss from concrete slabs.

Richard Kadulski has written a good book on heating systems called *Heating Systems for your New Hom*e which covers radiant floor systems in greater detail.☼

NRC·CNRC

Energy Savings from Modified Air Circulation

By John Burrows

Two recent studies conducted in the test houses at the Canadian Centre for Housing Technology (CCHT) have demonstrated the positive effects of using energy-efficient furnace fan motors and motor controllers. The studies compared the energy use of normal furnace operation in one house to the energy use with modified air circulation in the other house. At the start of each study, the two houses were benchmarked using identical fan motors to verify the similar energy use characteristics of the houses.

Brushless DC motors are significantly more efficient than permanent split capacitor (PSC) air circulation motors currently used in most residential furnaces. The efficiency improvement is especially apparent for heating systems that utilize continuous fan operation and reduced circulating airflow rates.

In the test involving brushless DC motors, electricity consumption was reduced by about 75% for continuous fan operation. This resulted in a reduction in total house electricity consumption during the heating season by up to 25%. For other times of the year there was a similar reduction in electricity required for constant movement of air, and a further reduction in the electricity required for cooling by about 10%. Natural gas use for heating increased about 14% to compensate for lower heat generation by the motor. The net effect was a significant reduction in overall energy use and, for areas where electricity is generated from fossil fuels, a significant reduction in greenhouse gas emissions.

Although effective, brushless DC motors are limited to new furnace installations because the retrofitting of existing furnaces is expensive and raises warranty and liability issues. For this reason, the second study was launched to investigate whether similar energy savings could be obtained by installing programmable timer devices on existing PSC fan motors, which would cause the fan to run at circulation speed for a specified time or until there was another call for heating or cooling.

The timers were tested during the heating and spring shoulder seasons in a fashion similar to the brushless DC motor study, except that both furnaces had standard PSC-type blower motors. In one test house the furnace fan ran continuously. The other house tested the use of the fan controller operated in four different circulation modes as follows:

- Continuous circulation: The fan was always running, either in heating or circulation speed.
- 30/30: The fan could be off for 30 minutes, then run in circulation speed for 30 minutes or until there was a demand for heat.
- 45/15: As above, up to 45 minutes off and up to 15 min on.
- Demand circulation: The fan ran only when there was a demand for heat.

The air leakage of both the (R-2000) test houses was adjusted to replicate typical 1990s-era air infiltration rates, and CO2 was introduced and distributed to simulate occupancy by four people. During testing the heat recovery ventilation system was turned off and the only mechanical ventilation came from the daily operation of the stove hood.

The results demonstrated that programmable timers installed on a PSC furnace fan can achieve energy savings similar to those of brushless DC motors, but at a much lower cost. A model used to project the effects of a controller for an entire heating season indicated that changing from continuous circulation to 30/30 could save 1,117 kWh of electricity (49% of the electricity used by the furnace) while increasing natural gas use by 130 m3 (7.6% of furnace gas use). A change from continuous circulation to 45/15 could save around 1,488 kWh of electricity (65%) while using an additional 173 m3 of gas (10.1%). Each circulation mode resulted in different CO2 concentrations, but they were within guidelines and within levels typically observed in Canadian houses.

For the majority of heating systems that operate in demand-circulation mode, the installation of a programmable fan controller will provide the ability to run the circulation fan for longer periods of time, resulting in better air circulation and a slight increase in total utility costs. For heating systems that currently use continuous circulation, the installation of a fan controller can be set to provide the optimum level of air circulation and a net decrease in utility bills.

Brushless DC motors can have a positive effect on air circulation and energy savings and are recommended for new home furnace installations. Programmable fan controllers are inexpensive, practical devices for providing variable amounts of air circulation to houses built since about 1990 that have conventional PSC fan motors, and even for houses built prior to 1990, which are commonly less airtight. ☼

For more information, contact Mike Swinton, Research Manager, Canadian Centre for Housing Technology. *Mike.Swinton@nrc-cnrc.gc.ca*

John Burrows is an Ottawa-based consultant and technical writer.
CCHT is a partnership involving IRC, Natural Resources Canada and Canada Mortgage and Housing Corporation. Located on NRC grounds in Ottawa, it began operation in 1999 and is used to accelerate the development of new technologies and their acceptance in the marketplace.

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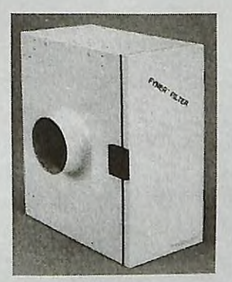
Did You Know?

Natural gas is used to heat the Alberta tar sands to extract the oil. However, it takes as much natural gas energy to extract the oil as the energy content in the oil that is delivered. As well, Canada exports about 60% of the natural gas produced.

Does this make sense? Is this rational thinking?

These may seem like obscure factoids, but the oil and gas industry is a huge part of the economy. There will be serious ramifications on the whole economy when oil and gas reserves are depleted. The building sector itself will be affected since buildings are a major portion of energy consumption, not only in their operation, but also in the embodied energy of the construction process.

What sort of a legacy are we leaving our children? ☼



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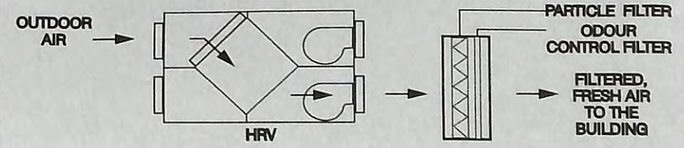

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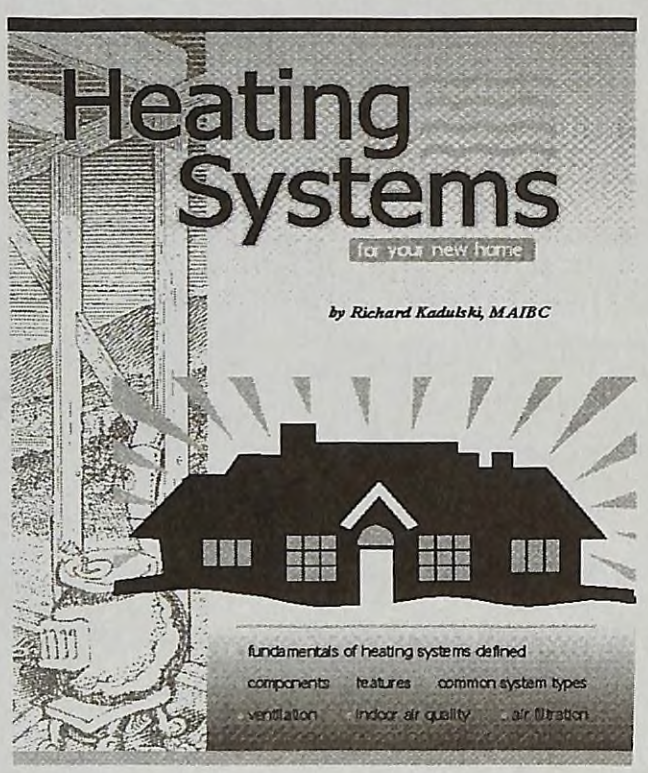
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